

# Fitness For Our Force

Functional Anatomy and  
Biomechanics

Cardiovascular and  
Respiratory Systems

Bones and Muscles and their Actions

**Lesson 2**



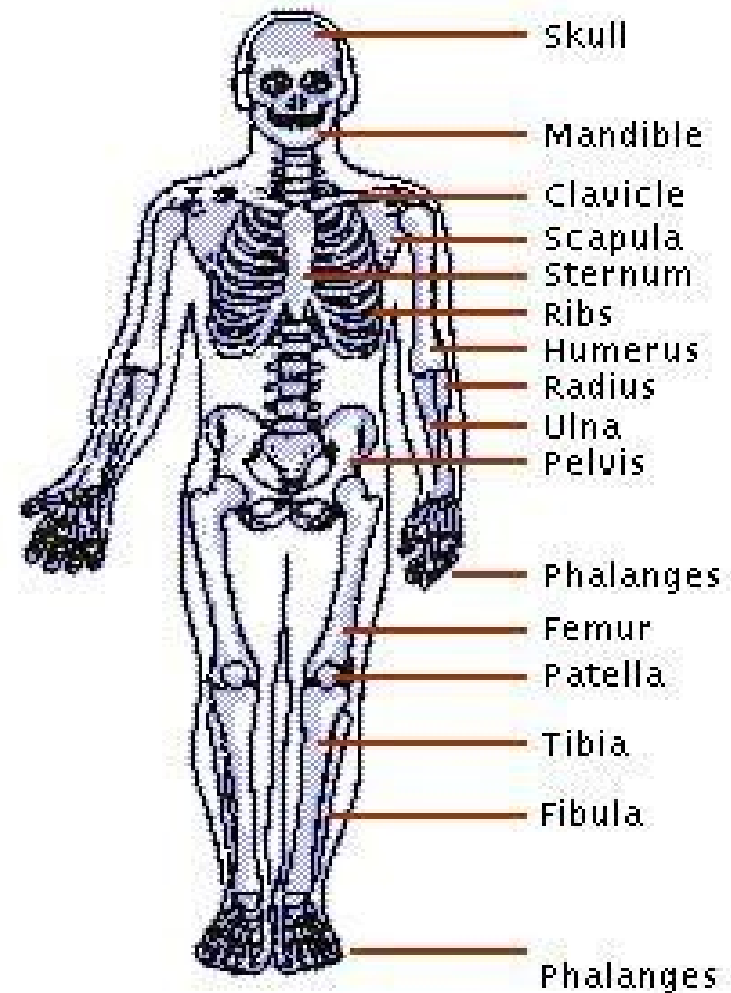


# The Bones and Muscles of the Body

For almost every move you  
make, you need two things  
BONES and MUSCLES.

# The Human Skeleton

- The skeleton is made of bones and joints that give it strength and flexibility
- ▢ The skeleton allows the body to move while protecting the soft organs inside.
- ▢ People are born with about 350 bones, some fuse together with growth. The skeleton of adults consist of 206 bones.





# SKULL

- ☛ Perched on top of the spine
- ▢ Consists of 29 bones
- ▢ Cranium- round part encasing the brain, 8 bones
- ▢ Face including lower jaw- 14 bones
- ▢ Ears- have 3 tiny bones
- ▢ Throat- single hyoid bone
- ▢ Major bones in the skull include the: frontal, nasal, maxilla (upper jaw), mandible (lower jaw), temporal, and occipital bones



# SPINE - “Backbone”

- ☛ Flexible chain of 2 dozen small bones called VERTEBRAS
- ☐ Protects the spinal cord
- ☐ Probably the most important bone in the body
- ☐ Column of 33 bones
- ☐ Made of many moving parts





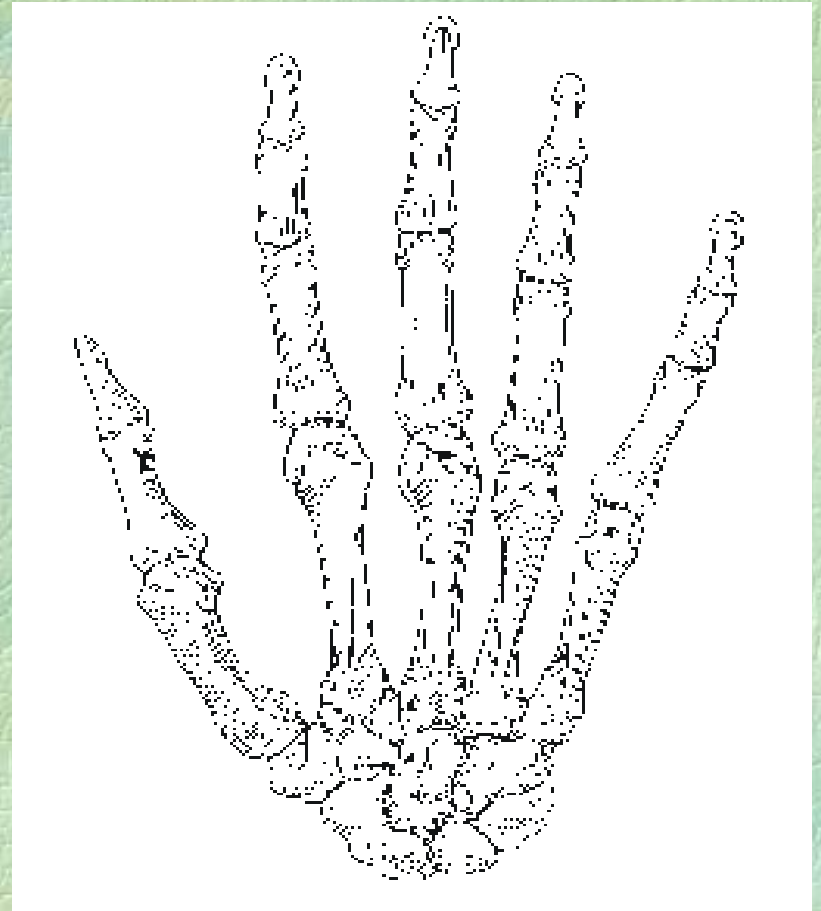
# CHEST & SHOULDERS

- ✎ 2 shoulder bones connect to the arms above the ribs, 2 collar bones are also found here
- The rib cage is attached to the spine. This set of bones surround and protect the lungs, heart, and other vital organs of the body.
- Men have 26 ribs, Women have 24 ribs
- The sternum is the breast bone above the ribs.
- Each shoulder consist of the clavicle (collar bone) and the scapula (shoulder blade).



# ARMS & HANDS

- Enable humans to work, feed, and defend themselves
- Bones:
- 1 upper arm: humerus
- 2 lower arm: ulna & radius
- 8 wrist bones: carpals
- 5 palm bones: metacarpals
- 14 bones make the fingers in each hand. Two phalanges are in the thumb, all other fingers have three.



# PELVIS

- 👉 Located at the base of the spine
- ☐ Supports the intestines and various organs of the abdomen
- ☐ Skeleton has 2 hip bones
- ☐ The sacrum and coccyx are fused here.





# LEGS & FEET

- ☛ Each leg has: 1 femur (thigh bone), patella (kneecap), tibia (shinbone), and one bone, fibula, on either side of the lower leg
- ☐ Thigh bones attach to the pelvis and connect leg bones to foot bones
- ☐ Leg bones enable humans to walk, stand, and run.
- ☐ The femur is the longest bone in the body.
- ☐ FEET- Each ankle consists of 7 bones called tarsals. Each foot consists of 5 bones, and 14 bones make the toes on each foot.



# What are BONES made of?

- 🦋 Bones are made up of proteins, living cells, and minerals.
- Some contain calcium. This mineral makes them hard and strong.
- Bones are the chief storage place for calcium.
- Inside the bones, you store many of the chemicals that come from the foods that you eat. The chemicals stored here are saved until your body needs to use them.
- All of the blood flowing in the body is made in the bones.
- Each bone is like a tube. The largest bones are hollow on the inside. If they were solid, they would be too heavy to move.



# Bone Composition

- Bones consist of two materials: dense outer material and a spongy, porous inner material.
- Center: This part of the bone contains the bone marrow. This is a soft substance that stores fat and produces new blood cells.
- Around the Marrow (Compact Bone): This long tube is made of smooth, solid bone. This gives the bone its strength and shape. It is made mostly of compounds of calcium and phosphorus.
- Light Rounded Ends: At the ends of the bones are spongy tissues with airspaces making the bones light but strong. This part of the bone is covered by smooth cartilage.



# Bone Marrow

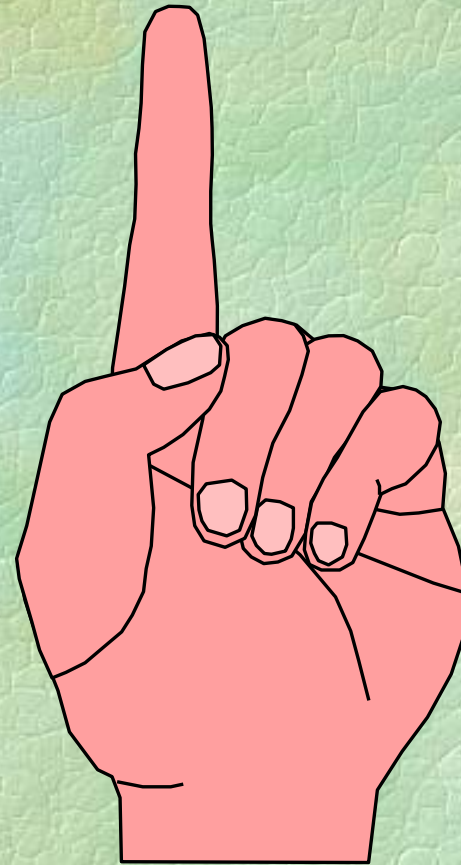
- 🦏 In the center of some hard bones you will find bone marrow.
- ☐ Bone marrow is a spongy material. If you were to look inside a bone, you might find red or yellow marrow.
- ☐ Yellow Marrow: These marrow cells store fat. This marrow is made of fat cells and simply stores fat.
- ☐ Red Marrow: These marrow cells make red cells of the blood. At the ends of some bones patches and streaks of reddish tissue may be found. This is from the red blood cells.
- ☐ Some of the bones make new blood cells in their marrow. Bones also store important minerals that the body uses and needs.



# Joints: The Meeting of

**Bones**  
Joints are where two or more bones come together.

- Immovable joints are held together by tough springy cartilage. (Cranium and Spinal Column)
- Moveable joints are held by thick cords of stringy ligaments.
- There are several types of joints.
- Without joints, your fingers would be straight.





🐸 **Tendons:** This is a tough fiber that attaches muscles to bones.

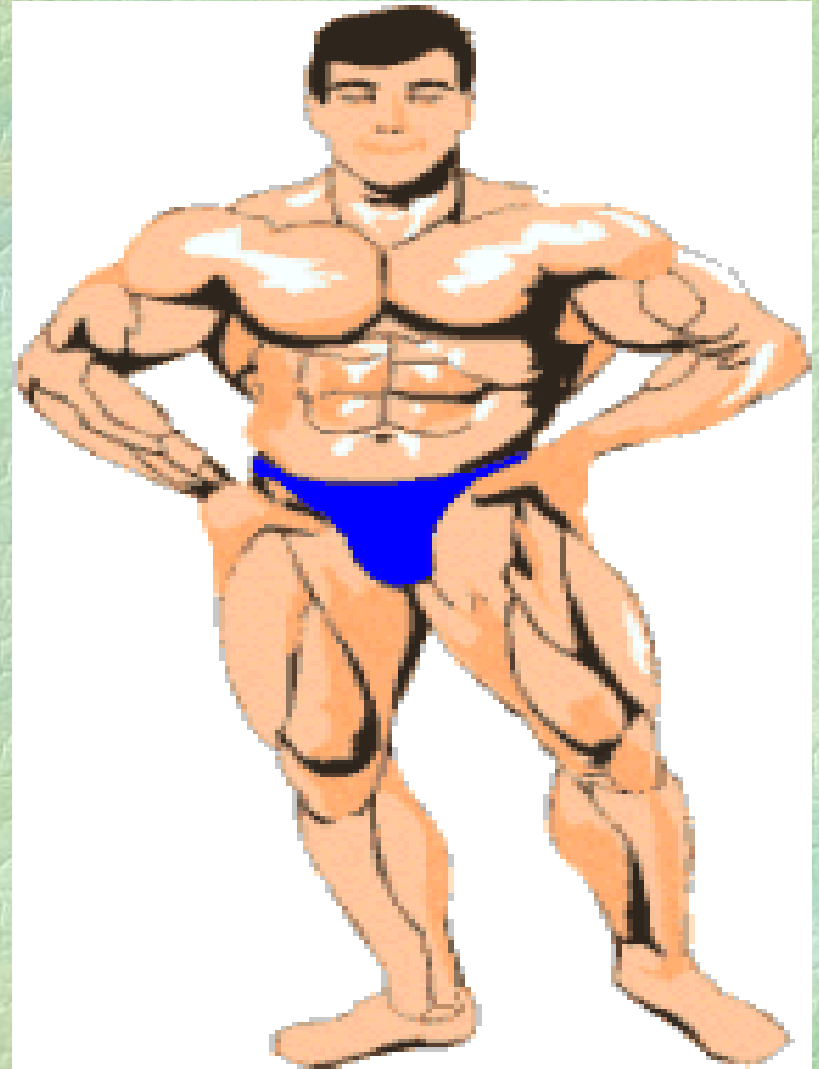
🐸 **Ligaments:** This strong stretchy band of tissues holds the bones together at their joints. Ligaments help hold bones together.

▢ **Cartilage:** This is a very soft bone found in the ears and nose. It can bend and allows for the free movement of bones at their ends.



# MUSCLES

- Muscles hold bones in place.
- ▢ There are over 600 muscles in the body totaling 1/3 of the body weight.
- ▢ Muscles give bones the power to move.
- ▢ Without muscles, you wouldn't be able to walk, run, or breathe.
- ▢ Muscles allow your body to change the energy from food into energy for movement.
- ▢ You can make controlled movements because of muscles.





# Muscles and the Brain

- Muscles are connected to the motor cortex in the cerebrum of the brain by sending out messages to control movements all over the body.
- ▢ You send a message from the brain to the muscle to make a movement. This makes the muscle to shorten, causing it to pull the bone toward another.
- ▢ Muscles are supplied with blood vessels and nerves that come from the brain and spinal cord.
- ▢ Blood provides the muscles with energy!





# Muscles need Food & Oxygen

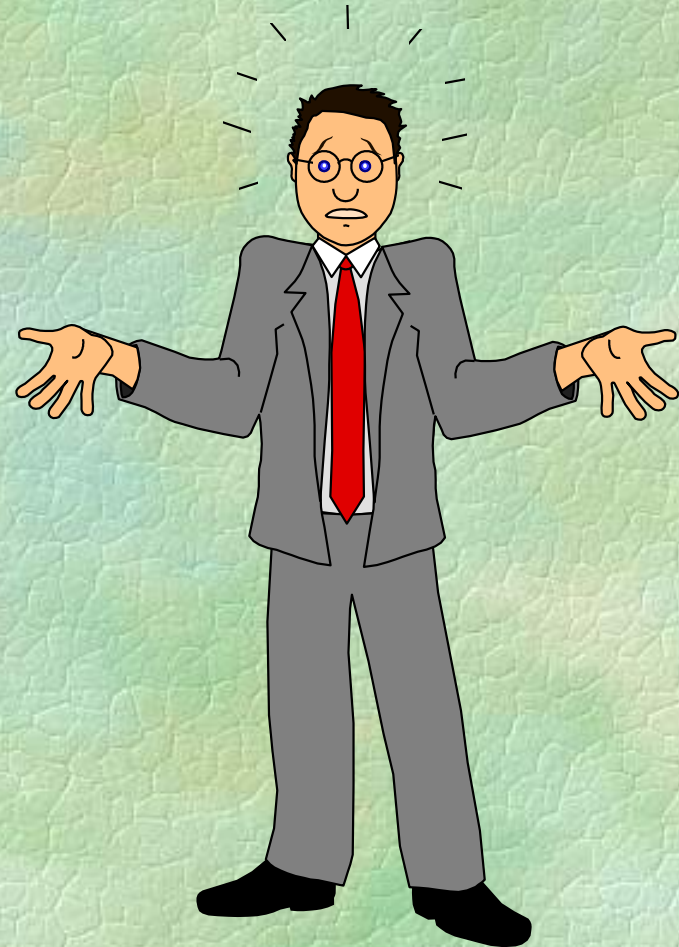
- Muscles need food and oxygen to work. The harder they work, the more they will need.
- ▢ Oxygen is taken from the blood to your muscles. When you run you breathe more quickly because the muscles need more oxygen. The heart beats faster to pump the blood more quickly.
- ▢ Food is stored in your body and used when needed. When your muscles start to work hard, extra food is released and carried to the muscles by the blood.





# What are muscles made of?

- ☛ Muscles are made of special cells that are long and thin.
- ☐ Each muscle is made of thousands of overlapping bundles of fibers. Each fiber bundle is a single muscle cell.
- ☐ Muscle fibers contain mitochondria and microfibrils.
- ☐ Microfibrils contain two types of tiny filaments - thick and thin. These filaments are made of different protein types. These proteins make a pattern of light (actin) and dark (myosin) stripes along the muscle fiber.





# Voluntary v. Involuntary Muscles

## VOLUNTARY MUSCLES

- ▢ You can move these muscles at will. You tell your brain to move these muscles.
- ▢ All of these muscles work in pairs.
- ▢ These muscles become tired quickly.
- ▢ Some of these: eyes, tough & soft palate, upper part of gullet, triceps, biceps

## INVOLUNTARY MUSCLES

- ▢ These are muscles you cannot control.
- ▢ Thousands of tiny involuntary muscles move your hair and give you goose pimples when you are cold.
- ▢ Some of these: heart, wall of intestines, walls of veins/arteries, stomach, gal bladder
- ▢ Your eyes contain both!



# Muscle Tissue

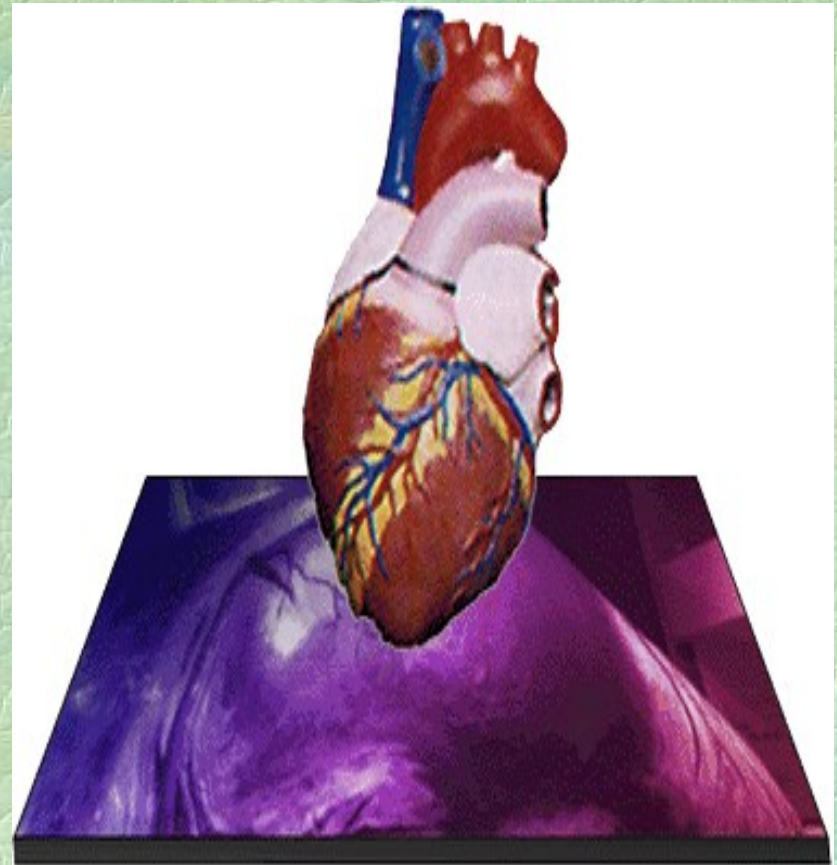
🐼 3 types: skeletal, smooth, cardiac

- ▢ **Skeletal Muscle Tissue:** This tissue is attached to the bones. These contract when the brain tells it to. These are considered voluntary muscles because they do what you want them to do.
- ▢ **Smooth Muscle Tissue:** This tissue allows parts of the body to move without you thinking about it. These are found in various internal organs like: walls of bladder, blood vessels, food canal, and iris of the eye.
- ▢ **Cardiac Muscle Tissue:** This is a special muscle that allows parts of the body to move without you telling it to. This is found in the heart.



# HEART MUSCLE

- The heart muscle is a thick and powerful muscle making up the walls of the heart chambers.
- ▢ This cardiac muscle contracts and relaxes all of the time.
- ▢ Veins carry blood to the heart. These walls contain less muscle because it is under less pressure.
- ▢ Arteries carry blood away from the heart. These walls contain a lot of muscle to withstand the pressure of the pumping.
- ▢ This muscle pumps blood all over the body.





# DIAPHRAGM MUSCLE

- 👉 The diaphragm is a sheet of muscle sitting just below the lungs. This muscle contracts and relaxes allowing space for the lungs to breathe in and out.
- To take a deep breath, the inter-costal muscles (in between ribs) push the ribs up and out. This allows for more space to fill the lungs.
- Breathe In: muscles attached to ribs pull ribs out, making lungs bigger
- Breathe Out: muscles relax, the ribs close in on the lungs pushing the air out



# Take care of your muscles.

- 🐼 Play sports and follow regular exercise programs to condition your muscles.
- ▢ Train your muscles, but don't over do it.
- ▢ Stretch your muscles before participating in an activity.
- ▢ Always warm-up before you begin an activity.
- ▢ Make sure you use the appropriate equipment to exercise your muscles.





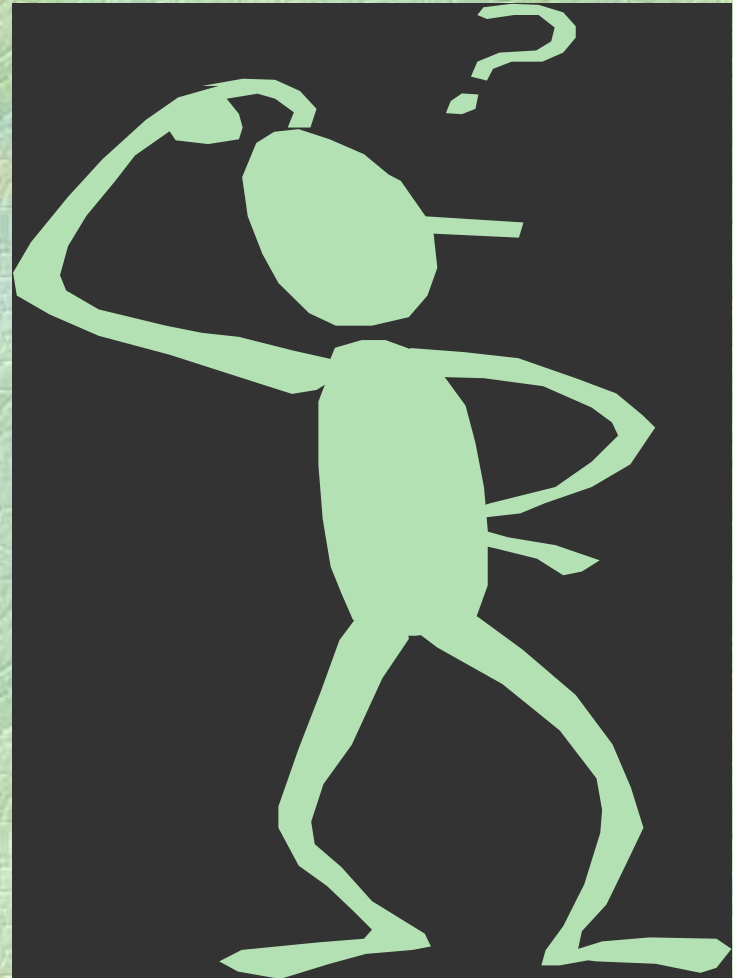
# Why Exercise?

- ☛ Exercise your muscles to keep them strong, healthy, and to get them to act together in the most efficient manner.
- ☛ When you exercise, your muscles produce carbon dioxide and become warm and acidic. The blood will release more oxygen so the muscles can work harder.
- ▢ If you exercise too long, muscles will make lactic acid, causing some pain. Rest allows this fluid to disappear from the blood and pain to vanish.
- ▢ Muscle tone is the natural tension in your muscles, exercise improves this.



# How do muscles work?

- Nearly all muscles work in groups, one will contract while the other relaxes.
- When muscles contract, they get shorter and fatter, pulling on the bone. Bones move when the muscle pulls on the tendons.
- Muscles can only pull. When one muscle pulls a bone one way, the other pulls it back.
- Muscles act on signals from the body's nerves and then provide the power to move the bones.





# Try this:

- ☞ Let one arm hang at your side.
- ☐ Put your hand over your bicep muscle in your upper arm.
- ☐ Pull your arm up bending it at the elbow.
- ☐ Feel your biceps contract.
  
- ☐ When your arm is straight, the tricep contracts and bicep relaxes.
- ☐ When you bend your arm, the bicep contracts and tricep relaxes.



# How are muscles attached?

- 🐭 The ends of muscles are attached to bone by tendons.
- ORIGIN of MUSCLE: the end of the muscle attached to the bone that it cannot move
- INSERTION of MUSCLE: the end of the muscle that is attached to the bone the muscle is intended to move.



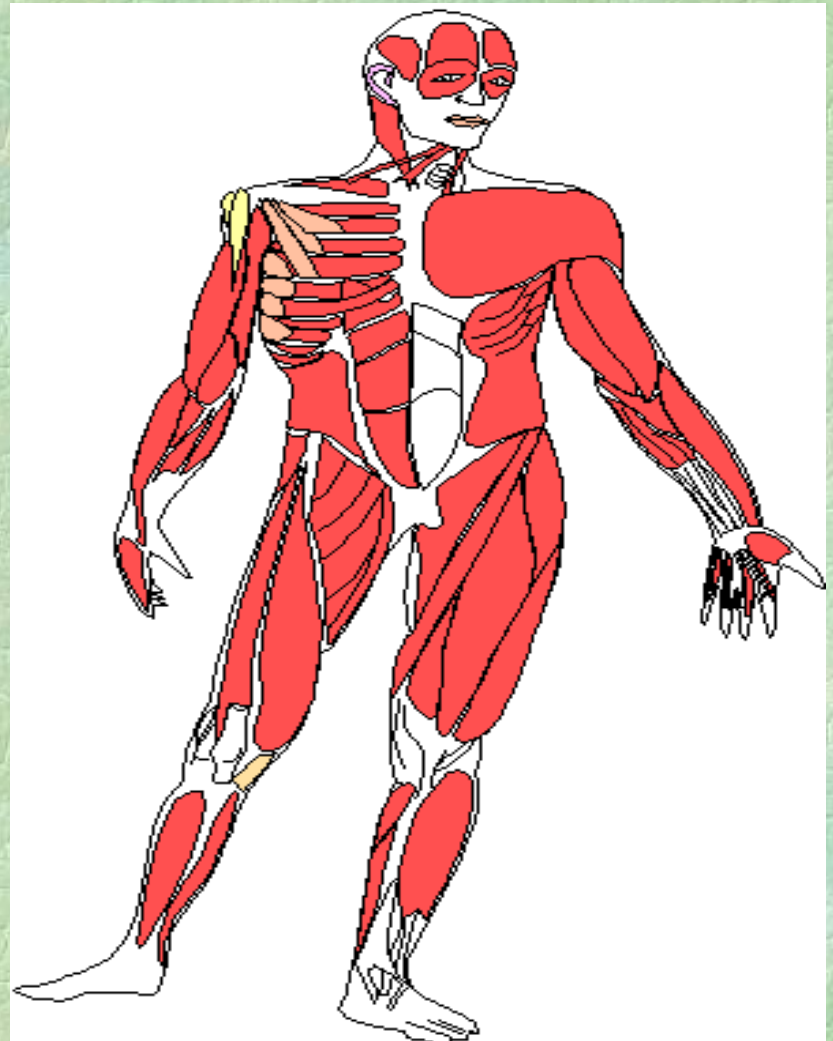
# What are the TENDONS for?

- 🐼 Tendon: a strip of tough cartilage that holds muscles to bones
- Some tendons are long. Fingers are moved by muscles in the arm.
- Muscles and tendons make up the *Muscular System*.
- The Achilles' tendon (behind the ankle) is the thickest and strongest of the body. It is 6" long and attaches the big calf muscle to the heel bone.



# Muscles in the ARMS and HANDS

- You can most control your hand muscles. About 30 muscles in each hand move your fingers. These help you make many small careful movements.
- ▢ TRICEP: straightens the elbow
- ▢ BICEP: bends the elbow
- ▢ INFRASPINATUS: pulls the arm against the body
- ▢ DELTOID: raises and twists the upper arm
- ▢ FLEXORS: bend the fingers





# Muscles of the CHEST and BOTTOM

☛ Many muscles exist in your organs. The stomach is made of several layers of muscle. These muscles squeeze inward even when it is empty. This is why you get “hunger pains.”

- ▢ Muscles in the esophagus push food into the stomach.
- ▢ RECTUS ABDOMINIS MUSCLES: found on either side of the naval, become tense to hold in a flabby tummy

☛ PECTOALIS MAJOR: pulls the arm in and rotates it

- ▢ INTERCOSTAL: move the ribs by raising them in breathing

- ▢ DIAPHRAGM: aides in breathing

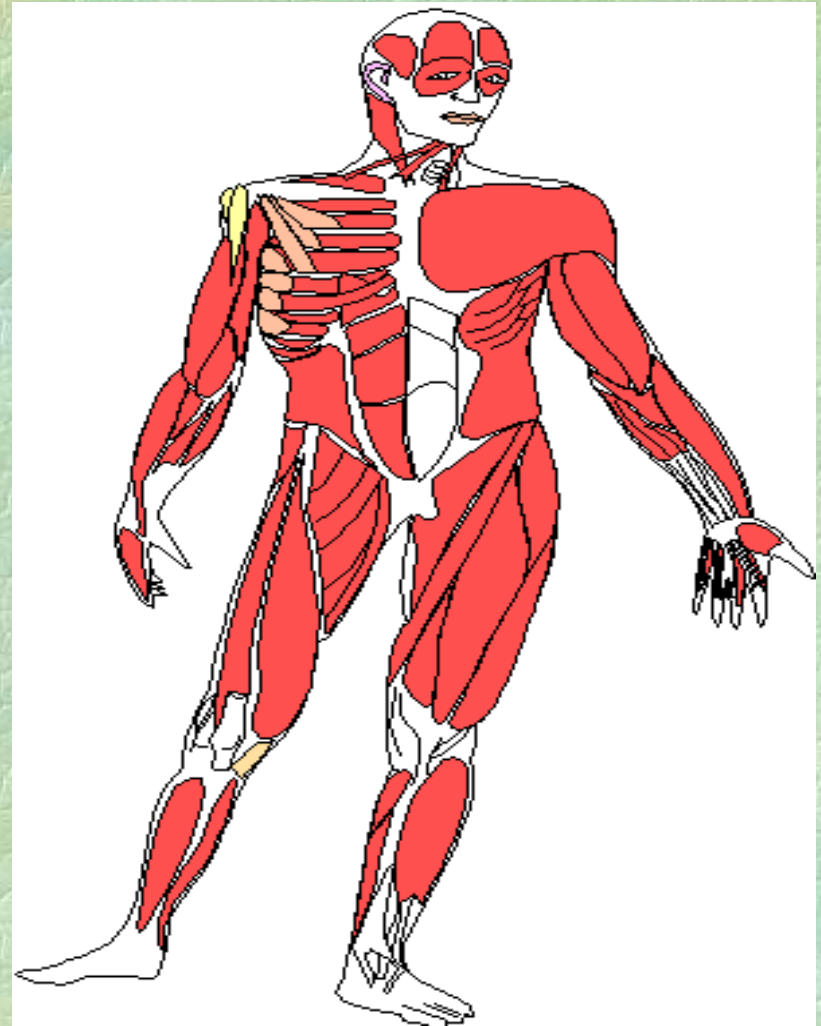
- ▢ GLUTEUS MEDIUS: pulls the thigh out to the side

- ▢ GLUTEUS MAXIMUS: straightens the hip for the skeleton to walk or run



# Muscles of the LEGS and FEET

- The biggest and strongest muscles lie here and in the bottom. These help push you forward when you run and jump.
- ▢ Leg muscles are long and straplike.
- ▢ QUADRICEPS: made of 4 smaller muscles in the thigh
- ▢ TIBIALIS ANTERIOR: raise foot
- ▢ EXTENSOR MUSCLES: raise ball of foot and curl toes up
- ▢ SARTORIUS: twist thigh, bends knee and hip
- ▢ GASTROCHEMIUS: lift heel, bend at knee
- PERONEUS: arches foot to tiptoe



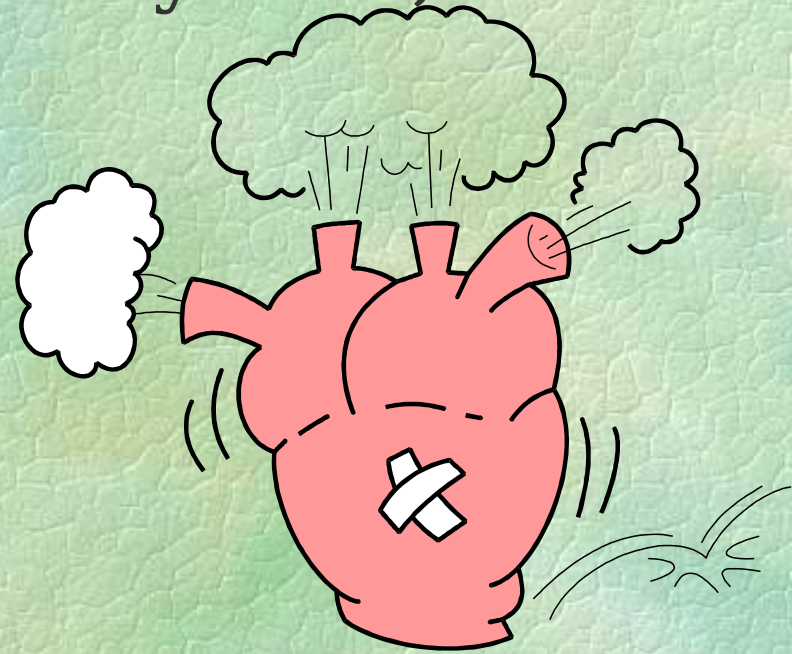


Keep your bones and muscles healthy. Eat a good diet and participate in a regular fitness program!



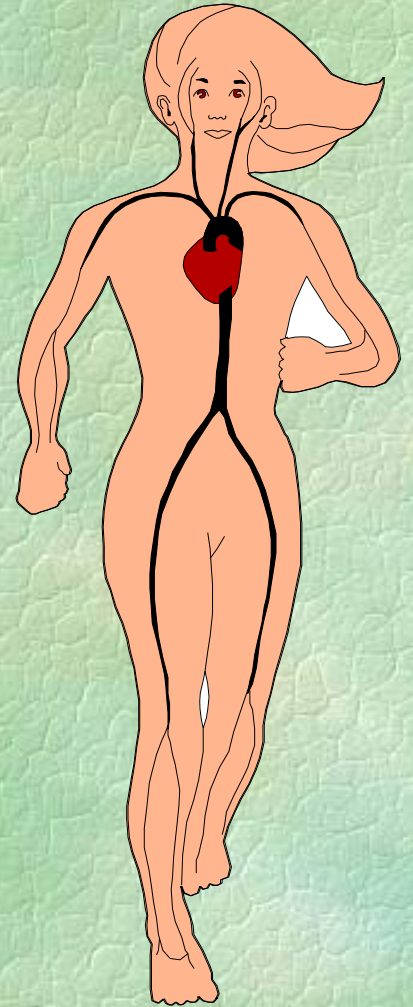
# 1.1

- Describe the Basic Anatomy of the Heart, Cardiovascular System, and Respiratory System.





# Cardio-Vascular- Respiratory Anatomy

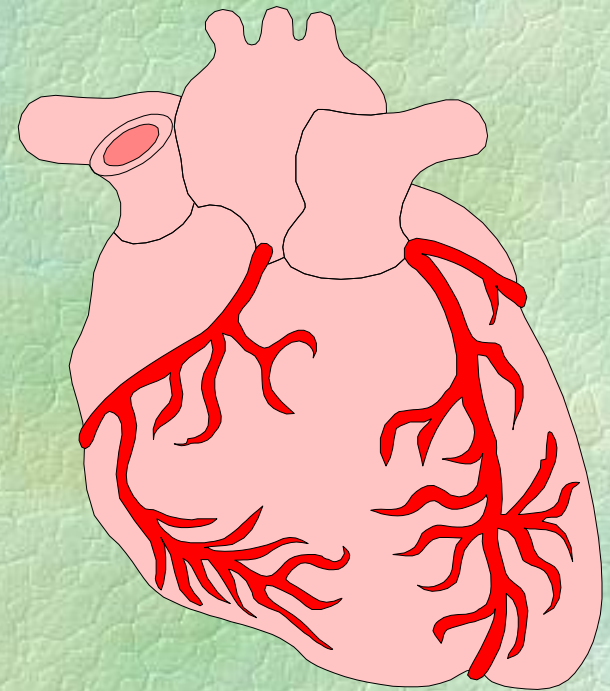




# Cardio Anatomy

🦋 The Heart

▢ Also Called 'Cardiac'

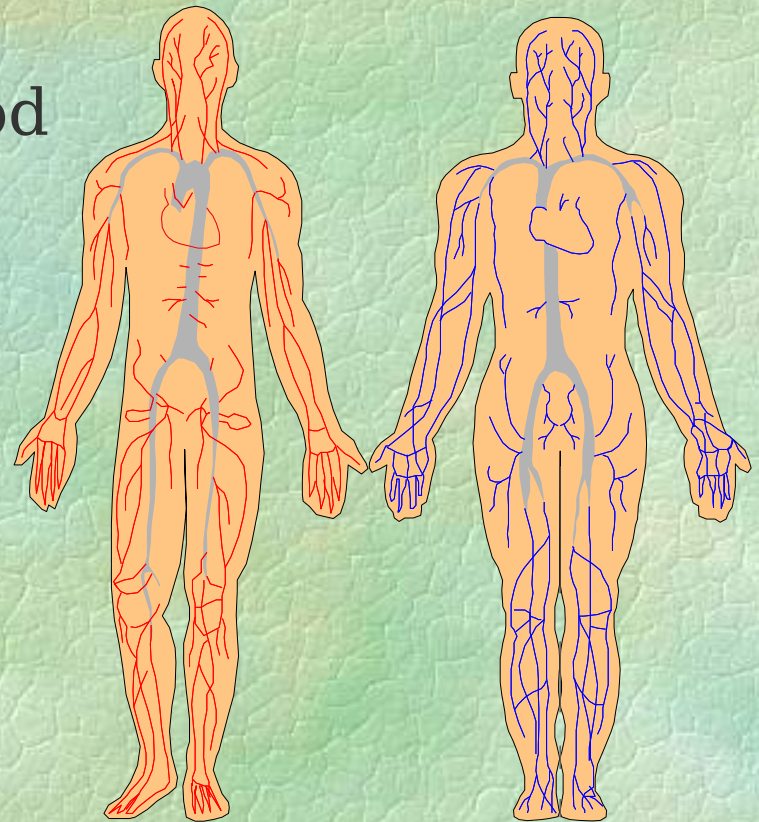




# Vascular Anatomy

## □ Blood Vessels

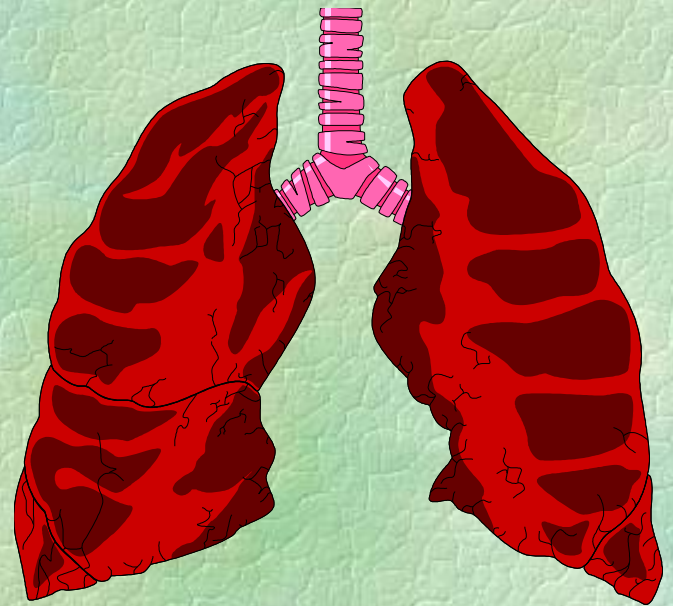
- **Arteries** (Carry Blood Away From Heart)
- **Veins**  
(Carry Blood to the Heart)





# Anatomy of the Respiratory System

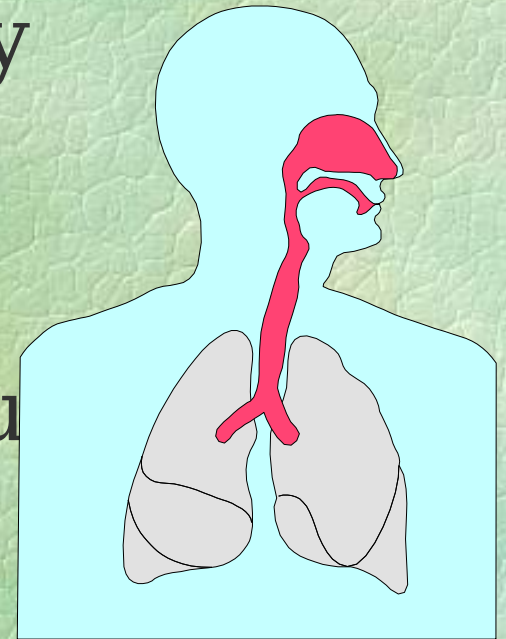
- Airways and Lungs
- Also Called 'Pulmonary'





# Respiration

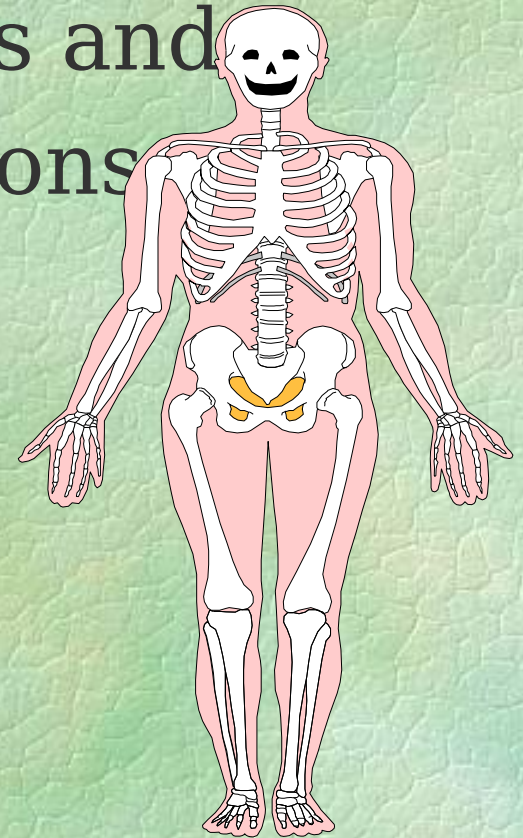
- Exchange of Oxygen and Carbon Dioxide Between the Atmosphere and the Cells of the Body
- Includes Inspiration (Breathing in) and Expiration (Breathing out)





# 1.2

- Identify the Major Bones and Muscles and Their Actions





Review -

what are the scientific terms?



# Major Bones

- Legs and Pelvis - Appendicular
- Spine, Ribs and Head - Axial
- Shoulders and Arms -  
Appendicular





# Legs and Pelvis - Appendicular

☞ Pelvis - Iliac, Isium, Sacral, Coccyx

☐ Femur - Thigh

☐ Tibia and Fibia - Lower Leg

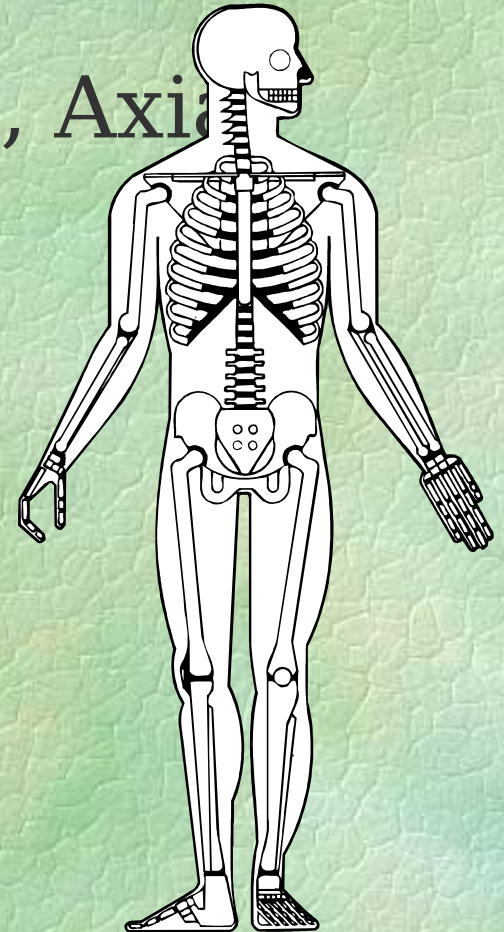
☐ Calcaneous, Talus, Tarsals,  
Metatarsals etc. - Ankle and Foot

- ***Hey Guys Remember “you can not fire a canon from a canoe”***



# Spine, Ribs and Head - Axial Skeleton

- Spine - Lumbar, Thoracic, Axial
- Ribs - Ribs
- Head - Skull





# Shoulders and Arms - Appendicular Skeleton

- Clavicle - Collar Bone
- Scapula - Shoulder Blade
- Humerus - Upper Arm
- Radius and Ulna - Lower Arm
- Carpals, Metacarpals, Etc. - Wrist and Hand



# Major Muscles

- Legs - Largest Muscles in the Body
- Trunk - Stabilization
- Chest and Back - Largest Range of Movement
- Shoulders and Arms



# Legs -

## Largest Muscles in the

### Body

- Gluteus - Buttocks

- Quadriceps - Front of Thigh
- Hamstrings (Biceps Femorous) - Back of the Thigh
- Gastroc. (Gastromenous) - Large Calf Muscle
- Soleus - Powerful Calf Muscle Under the Gastroc.



# Trunk - Torso Stabilization

- Rectus Abdominus, Obliques, Intercostals - 'Abs'
- Erector Spinea - Low Back
  - *most often forgotten during work outs.*



# Chest and Back - Largest Range of Movement

- ▢ Pectorals Major and Minor - Chest
- ▢ Rhomboids - Between the Shoulder Blades
- ▢ Latimus Dorsi - Mid Back (*the “V”*)
- ▢ Trapezius - Upper Back/Lower Neck



# Shoulders and Arms - an Extension of the Chest/Back

- ▢ Deltoids - Shoulders
- ▢ Bicep Brachii - Bicep, the Front of the Arm
- ▢ Tricep - Tricep, the Back of the Arm



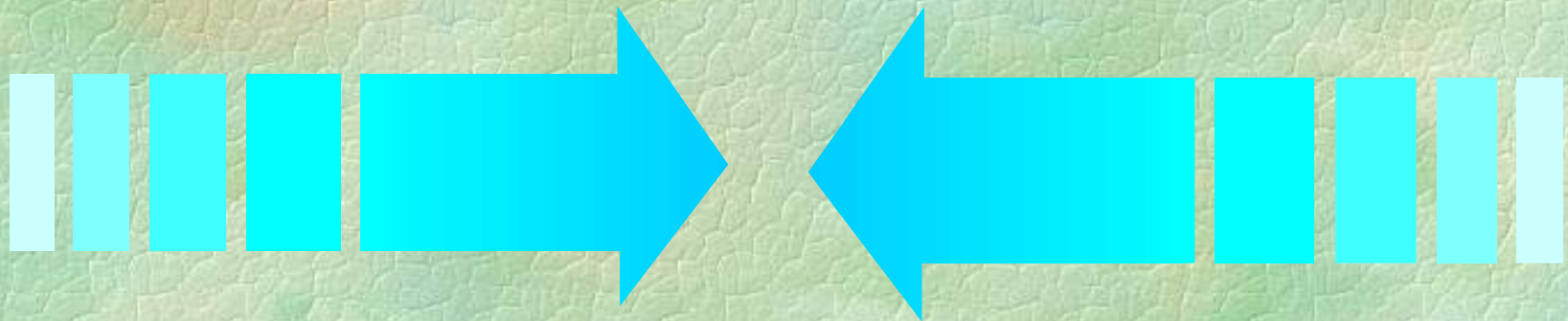
# 1.3

- Identify the Major Joint Actions:
  - Flexion, Extension, Adduction, Abduction, Rotation, Supination, and Pronation



# Flexion

- Movement About a Joint in Which the Bones on Either Side of the Joint Are Moved Closer Together

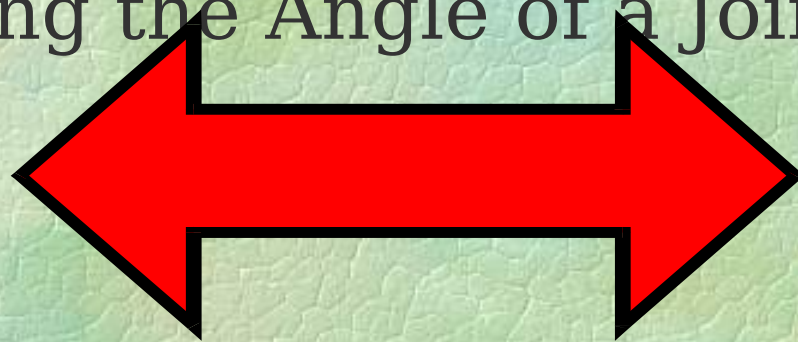


- The Opposite of Extension



# Extension

- ☞ Movement at a Joint, Bringing the Body Parts Into or Towards a Straight Line
- Increasing the Angle of a Joint

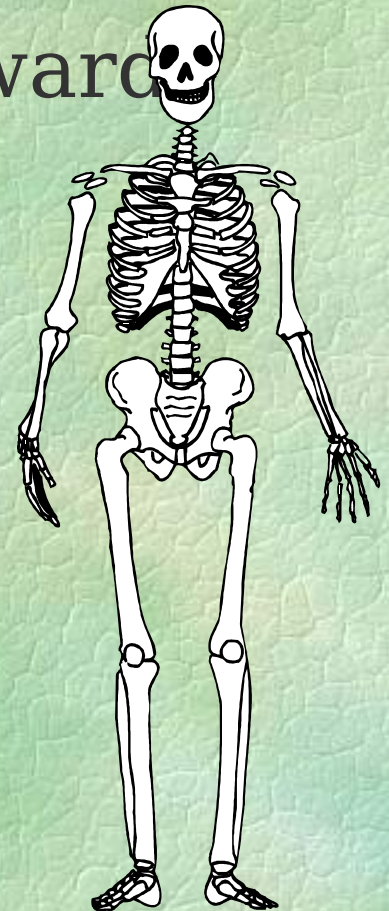
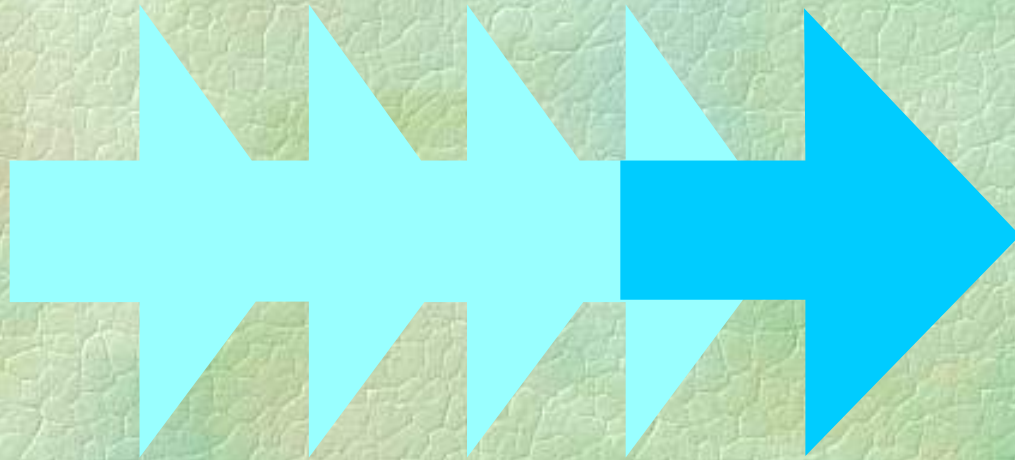


- The Opposite of Flexion



# Adduction

☞ Movement of a Body Part Toward the Midline of the Body

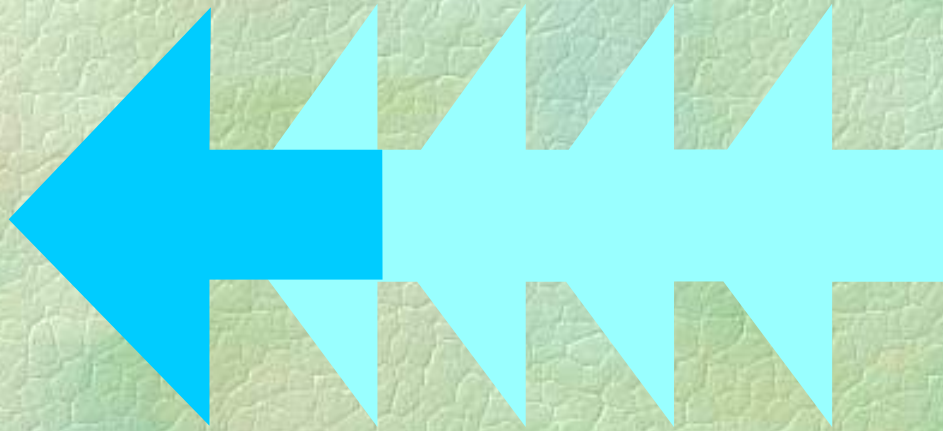


☐ Remember “Add” -- to Add to the Body



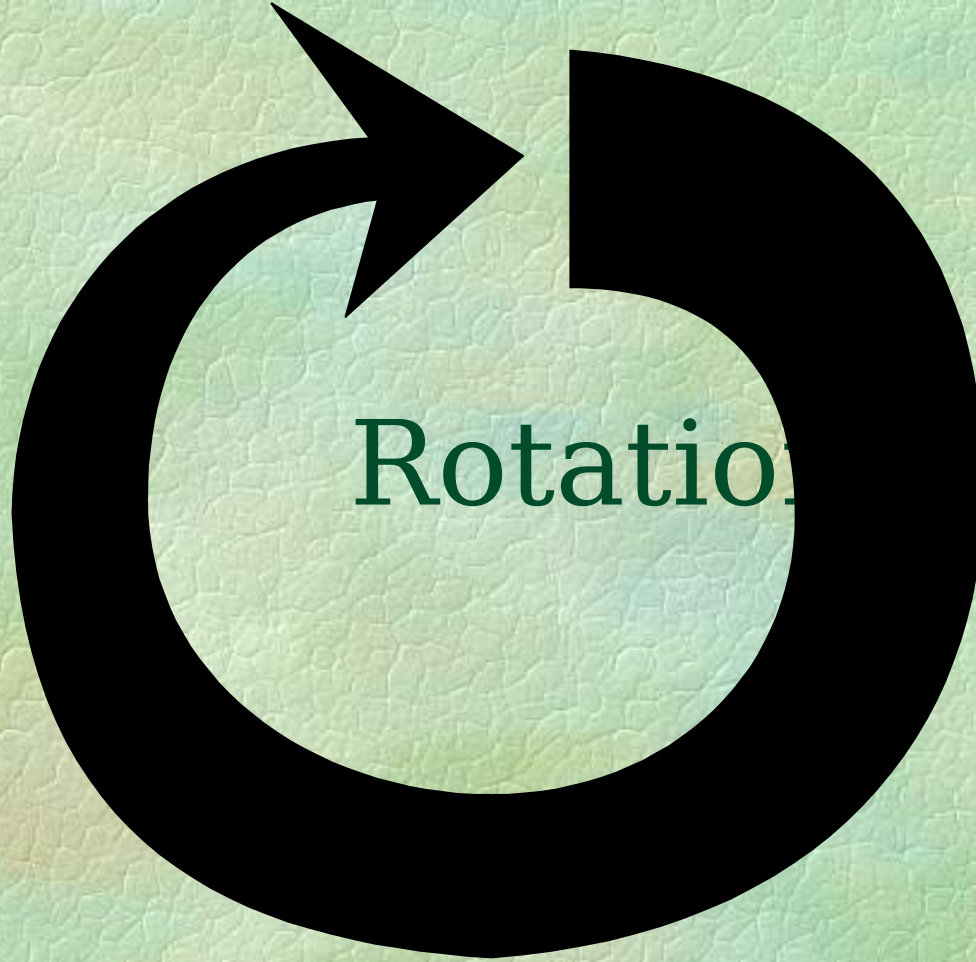
# Abduction

☞ Movement of a Body Part Away From the Midline of the Body



☐ The Opposite of Adduction





- Movement of a Body Part Around a Fixed Point



# Supination

- Assuming a Horizontal Position Facing Upward
- In the Case of the Hands, It Also Means Turning the Hand Forward
- *Remember “Sup” --Like a Bowl of Soup*

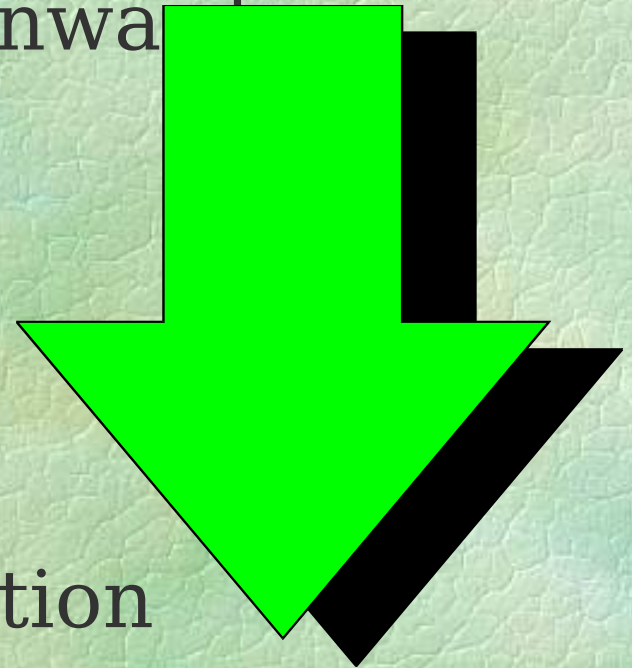




# Pronation

- Assuming a Face Downward Position
- Regarding the Hand, Turning the Palm Backward or Downward

- The Opposite of Supination



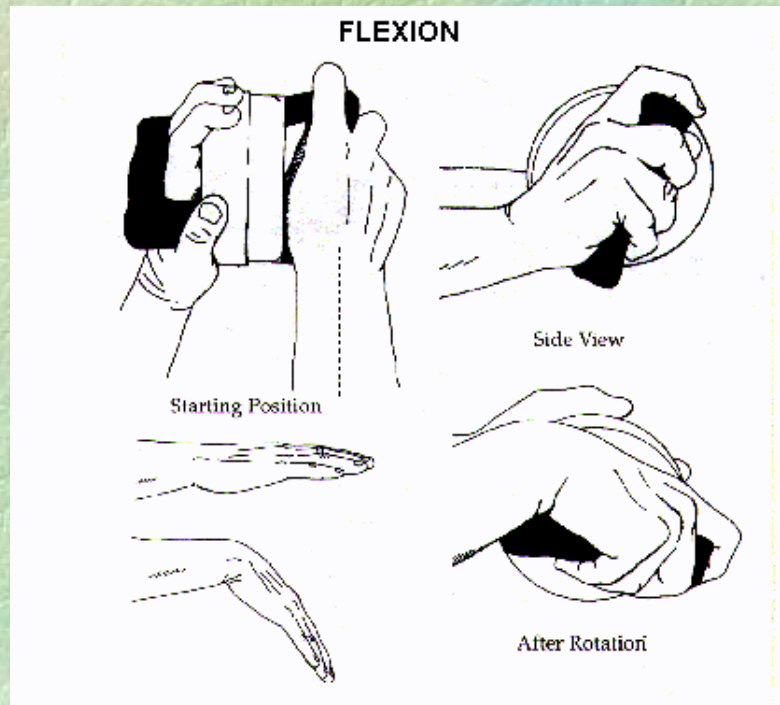


# Major Joint Actions



# Flexion

- Decrease in the angle at a joint by moving in the sagittal plane around a mediolateral axis





# Flexion (cont'd)

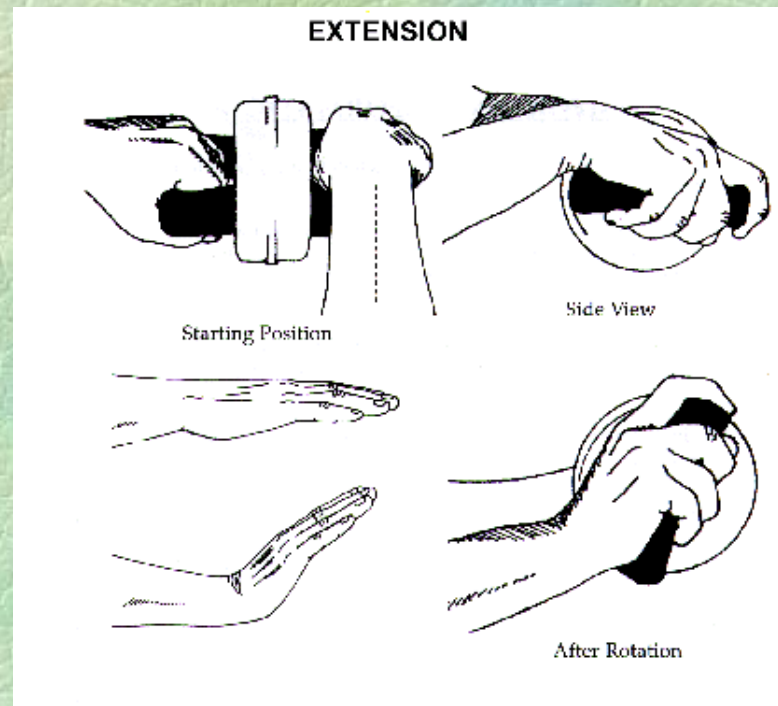
□ This exercise strengthens the following muscles:

- Flexor carpi radialis
- Flexor carpi ulnaris
- Flexor digitorum superficialis
- Flexor digitorum profundus
- Palmaris longus



# Extension

- Increasing the angle at a joint by moving in the sagittal plane around a mediolateral axis



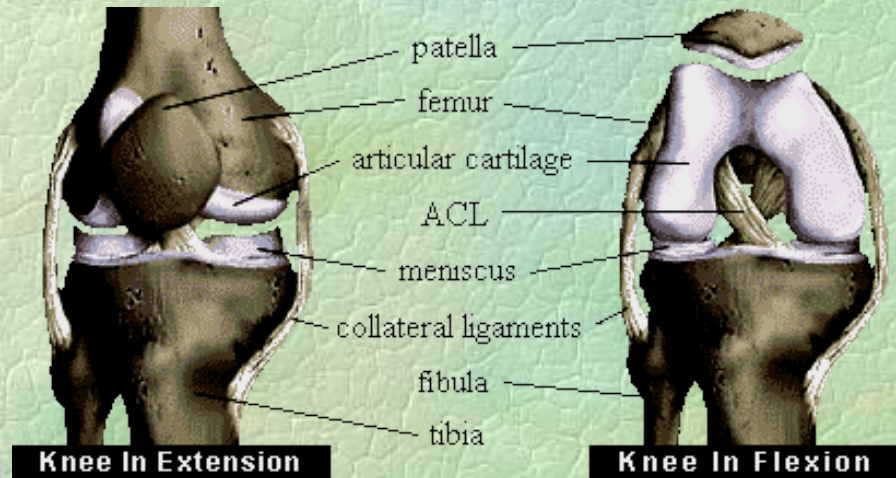


# Extension (cont'd)

- This exercise strengthens the following muscles
  - Extensor carpi radialis longus
  - Extensor carpi radialis brevis
  - Extensor carpi ulnaris
  - Extensor digitorum communis



# Other Examples





# Adduction

- Movement in the frontal plane away from the midline of the body around an anteroposterior axis

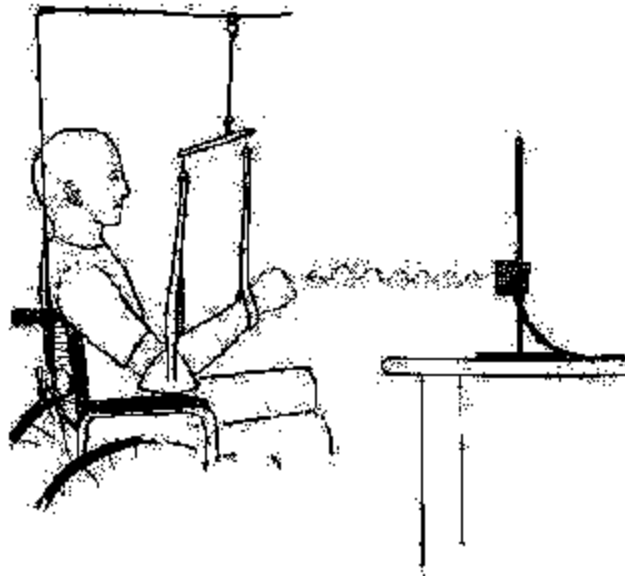


# Abduction

- Movement in the frontal plane toward the midline of the body around an anteroposterior axis

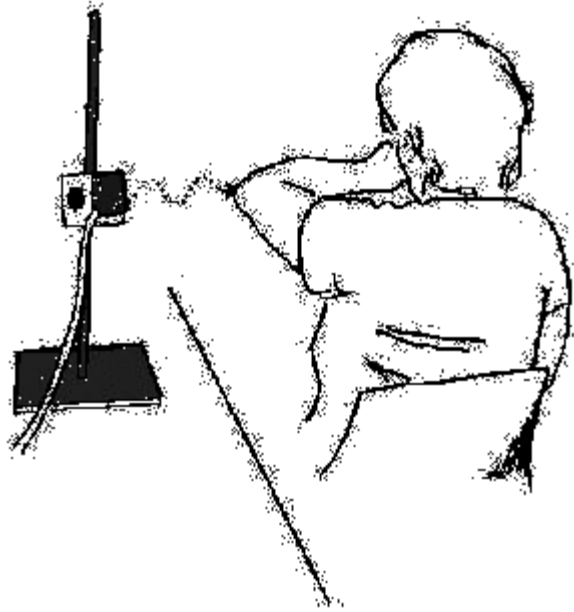


# Shoulder Abduction





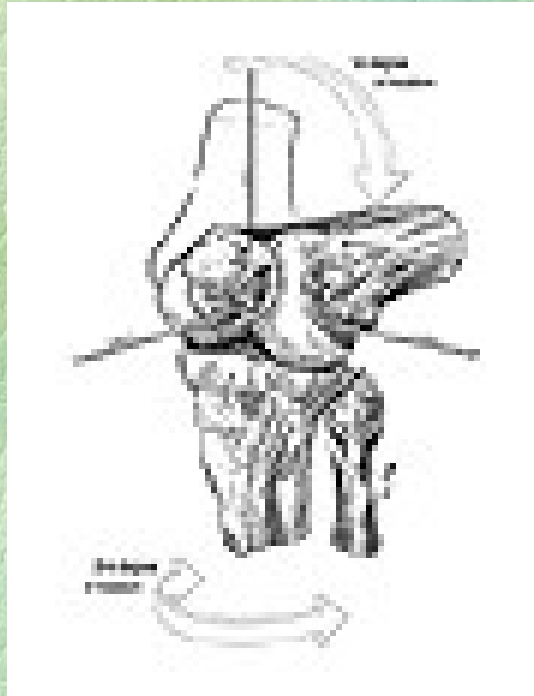
# Shoulder Adduction





# Rotation

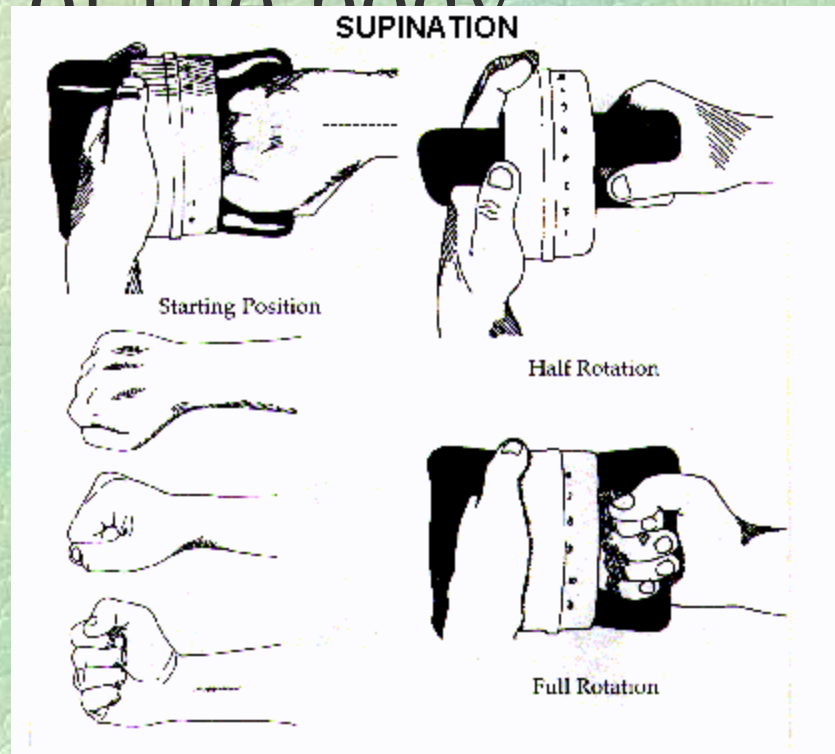
- A movement in which the shoulder turns along the long axis of the shoulder





# Supination

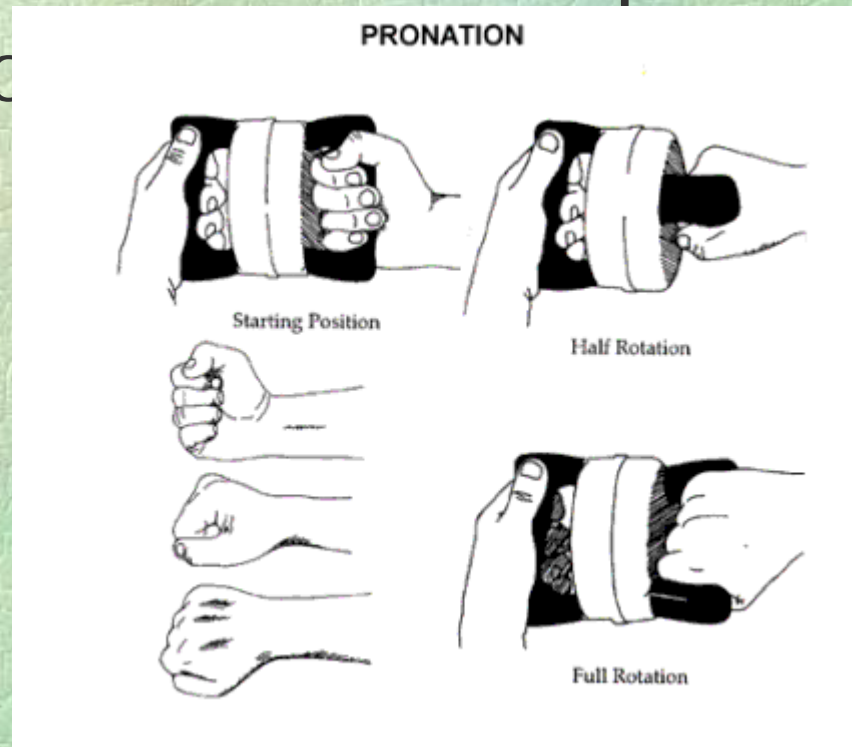
- Turning the palm of the hand forward toward the anterior aspect of the body





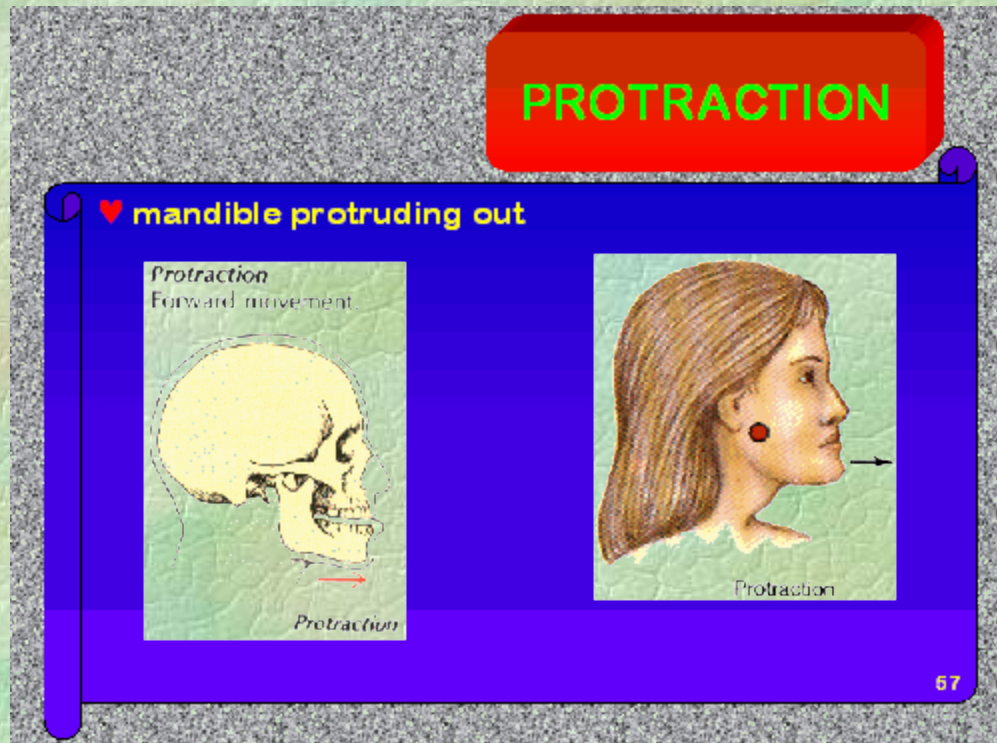
# Pronation

- Turning the palm of the hand inward toward the posterior aspect



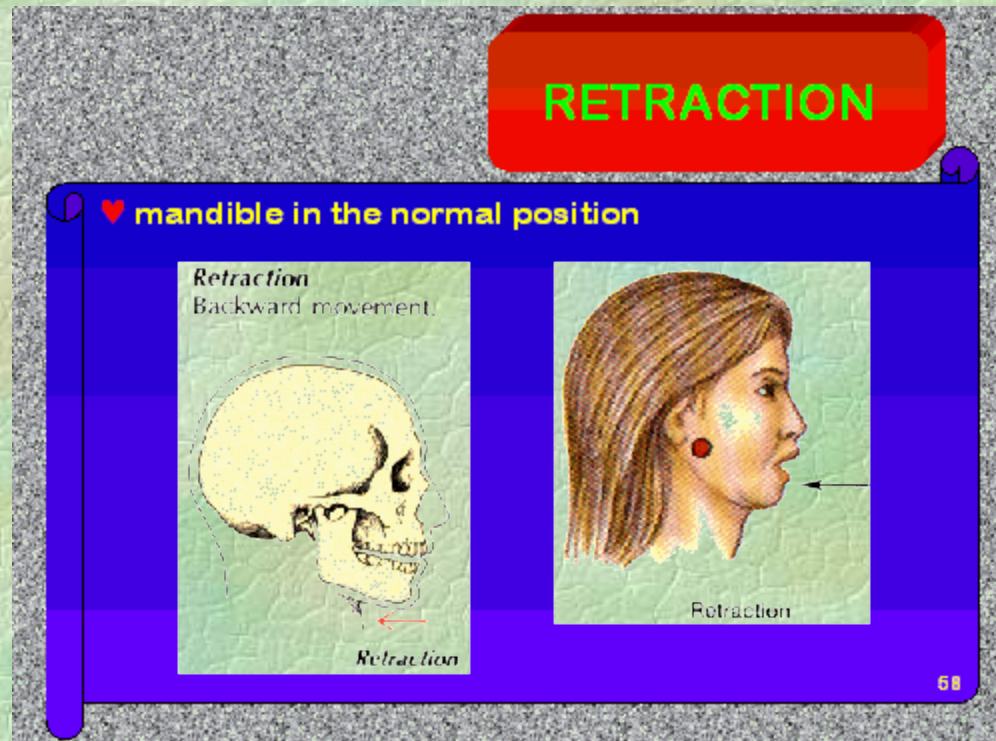


# Protraction





# Retraction





# Elevation



## ELEVATION

♥ lifting superiorly

♣ ex. shrugging the shoulders

♣ ex. elevating mandible to close the mouth





# Depression

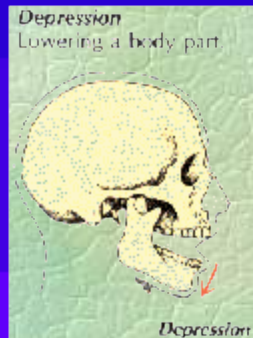


## DEPRESSION

♥ moving inferiorly

♣ ex. drooping the shoulders

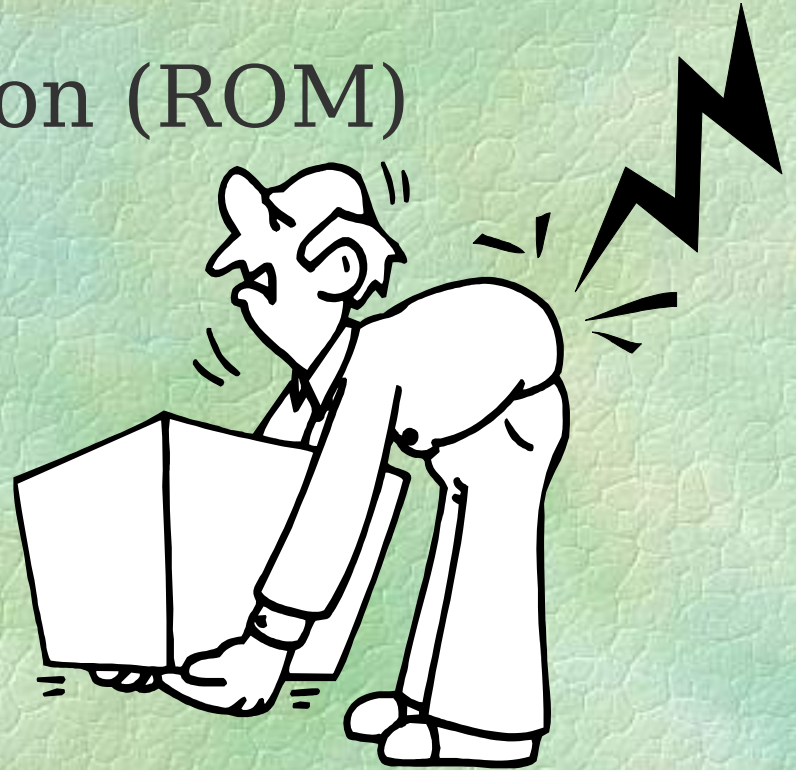
♣ opening the mouth





# Biomechanics - Good Form & Injury Prevention

- ❑ Full Range of Motion (ROM)
- ❑ Momentum
- ❑ Good Form





# 1.4

- Identify Naturally Occurring Weak Links
- Low Back, Neck, Knee Joint, and Shoulder Joint



# Low Back

- Use of Weight Lifting Belts -
  - Does Not Necessarily Help Low Back
  - Does Not Reduce Likelihood of Injury

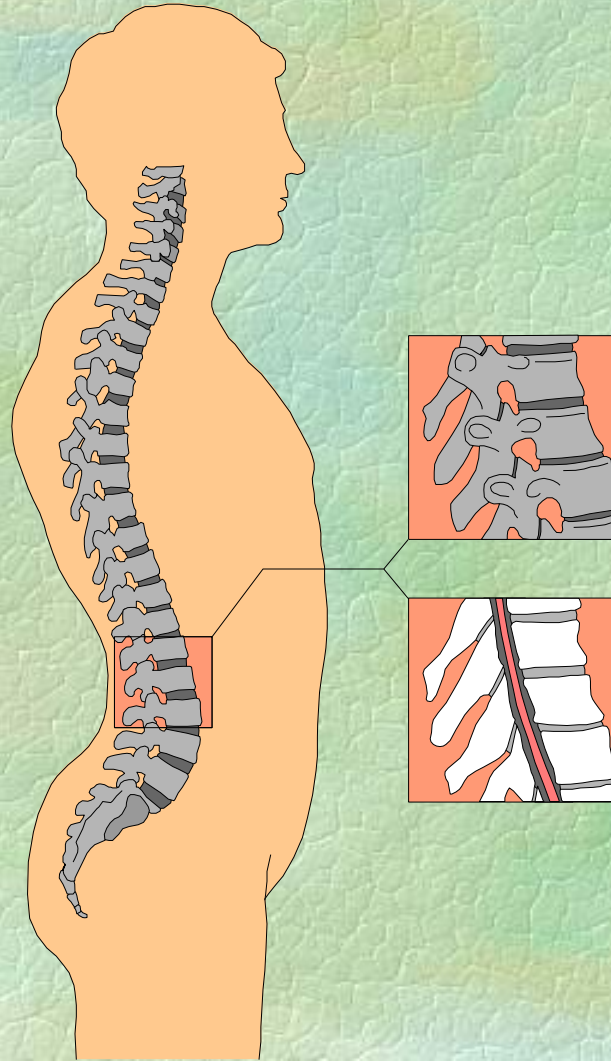


# Low Back

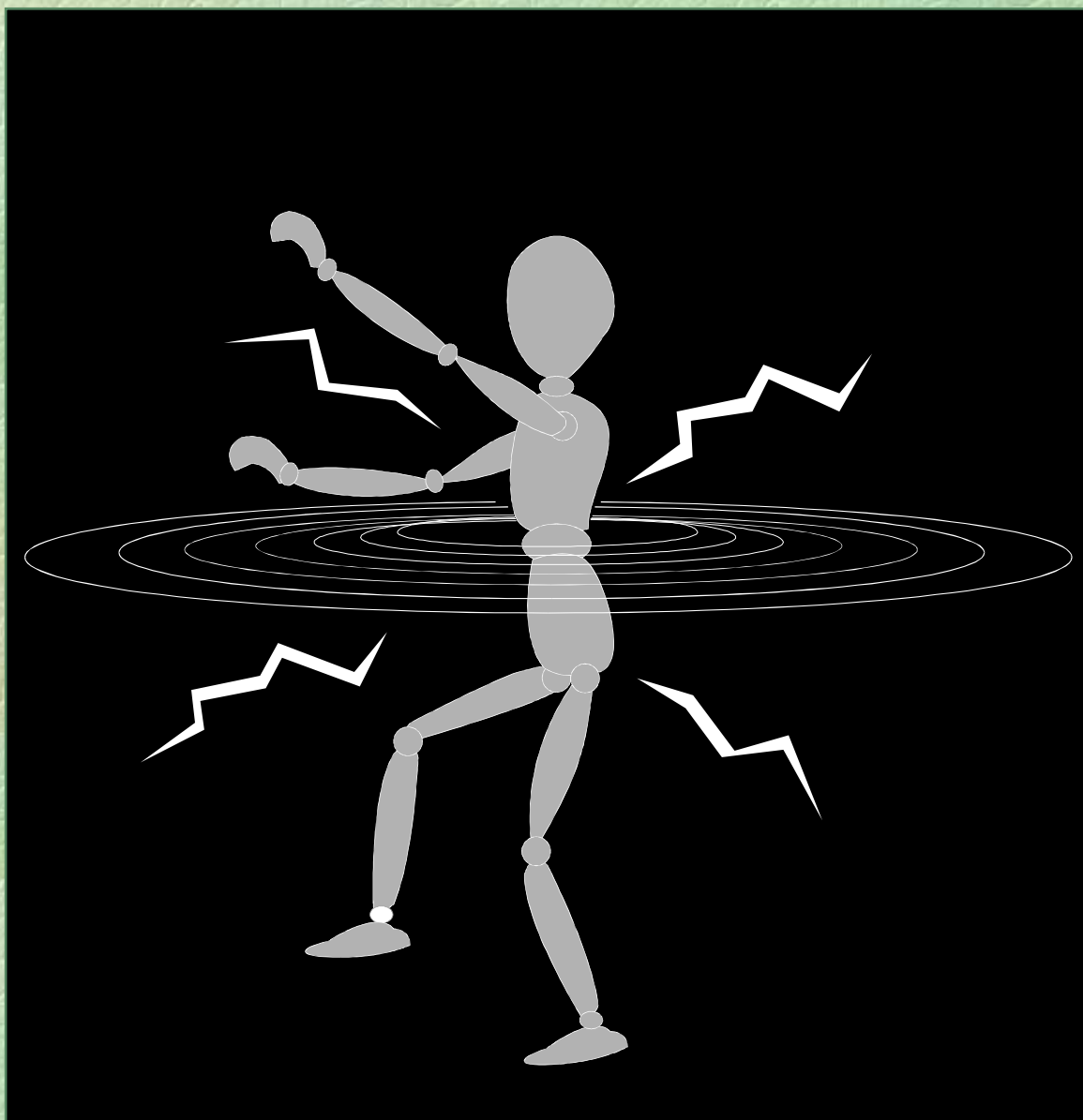
- Usually Not “Worked-Out” - a Forgotten Area
- Increasing Flexibility of Low Back and Hamstrings
  - improves posture



# Posture - Abdominal Adipose Tissue and Weak Abs









# Neck

- Not Frequently ‘Worked-Out’
- Posture
  - Dowagers Hump



# Knee Joint

- Without Proper Biomechanic the Knee Is Highly Susceptible to Injury



# Knee Joint

- Do ***Not*** Let Knees Move in Front of Toes While Squatting or Lunging





# Shoulder Joint

- Great Range of Motion



# Shoulder Joint

## □ ***Highly Susceptible to Injury***

- Rotator Cuff Injuries
- Behind the Neck Press or Lat. Pull Down
- Muscle Imbalances - Overdeveloped Anterior and Medial Deltoid